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DOPPLER GEODETIC POINT POSITIONING DATA BASE USED AT DMA,(U)
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This is a narrative report dealing with the automation of Doppler Geodetic Point Positioning Data at the Defense Mapping Agency Hydrographic/Topographic Center. The data base files are geared to meet the needs of both the technician and the geodesist for supplying geodetic data to users throughout the world, and performing analysis and evaluation of results generated from the data base. Included is a brief description of format design and the choice of solution. Future programs and applications are also discussed.

Doppler Geodetic Point Positioning

Data Base Used at DMA

by

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ABSTRACT

This is a narrative report dealing with the automation of Doppler Geodetic Point Positioning Data at the Defense Mapping Agency Hydrographic/Topographic Center. The data base files are geared to meet the needs of both the technician and the geodesist ~~for supplying geodetic data to users throughout the world~~, and performing analysis and evaluation of results generated from the data base.

Included is a brief description of format design and the choice of solution. Future programs and applications are also discussed.

For presentation to the International Symposium, Management of Geodetic Data, 24-28 August 1981, Copenhagen, Denmark.

1. INTRODUCTION.

The Defense Mapping Agency (DMA) has been using artificial Earth satellites for Doppler Geodetic Point Positioning (DGPP) for over a decade. The collected information is available ~~for~~ over 3,000 stations throughout the world. DMA has been instrumental in preparing standards for the acquisition of data (Field Operations Manual, Doppler Geodetic Point Positioning 1975) and final documentation of the results (Satellite Records Manual, Doppler Geodetic Point Positioning 1976). The observance of these procedures has led to an extremely high degree of integrity in the collected data.

These satellite-derived positions have contributed greatly to our knowledge of the Earth. DMA has pursued for many years the unification of survey datums throughout the world. What was once a ~~dream~~ has become a reality. Now our scientists and engineers are using these satellite-derived coordinates to map and study our Earth in even greater detail.

2. BACKGROUND.

As the positional and related data began to accumulate, the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) was designated the central point of contact for the Department of Defense, with responsibility for collecting ~~and supplying~~ DGPP information ~~to users~~ throughout the world.

From the beginning, these DGPP data have been documented on summary control cards, which have been hand typed. The control card has undergone several format changes throughout the years. The current "Summary of Satellite-Observed

Station" card is shown in Figure 1. The circled numbers in each entry are described in the DMA Technical Manual T-3-52320.

One of the first requirements for an automated system was to provide users with a computer listing of the available Doppler holdings in DMA files. An 80-column "CHECKLIST FILE" was created, containing data elements: station number, station name, continent (or ocean) name, country (or state) name, and a code indicating what data are available for the station.

CODE

Reports
- O = Station Occupation Report (SOR).
- I = Geodetic Information Report (GIR).
- C = Summary of Satellite-Observed Station card.

Descriptive Material
- D = Description.
- K = Survey Sketch.
- E = Station Site Sketch.
- P = Photoidentified or photoidentifiable.

Coordinate Data
- L = Position surveyed to local datum.
- T = Position transformed to local datum from satellite-derived position.
- S = Satellite-derived position and ellipsoid height.
- A = Astronomic position.
- H = Elevation surveyed to a level datum, (usally mean sea level).

Table 1. AVAILABILITY LETTER CODES

To provide the latitude and longitude of the points, another 80-column "SATELLITE FILE" was created. The unique Doppler station number was used to tie the files together. A sample of the listing of holdings, published quarterly, is illustrated in Figure 2.

3. DATA FLOW PROBLEMS

As more and more requests for the data were ~~received~~, it became evident that more geodetic data should be put in machine-readable format. A better data handling system would also need to be developed. While designing this new information handling system, additional data were keypunched using an 80-column card format. The "GEODETIC FILE" and "MSL FILE" contained the basic information on terrestrial surveys.

Problems with the existing 80-column card filing system were:

- It had sequential addressing only.
- It was hard to add new data elements.
- It was cumbersome to manage and use.
- Changing requirements were hard to accommodate.

As more and more demands were made on accessing the data stored in the 80-column format files, it became essential that the data be directly accessible.

A new data base system was written using the programming language FORTRAN. FORTRAN was chosen since most geodesists and mathematicians working with these data were well versed in this language and could maintain and make necessary changes to the system to support changing DoD requirements. The system was developed by the users who had knowledge of the problems, and with the aid of direct computer specialist support (Peroutka 1979). This very small group promoted good communications and quickly developed the DGPP information handling system.

Since the technicians were familiar with the existing 80-column card-image formats, the new system was designed to be maintained using these same formats. This user-oriented system would require minimum changes to the existing processing and validation methods, while providing an efficient storage and retrieval system. Quality and completeness of the data were of prime concern in creating the new system.

4. DATA BASE STRUCTURE

The data base handling system allows both random access and sequential retrieval capability to the stored records. The system runs on the UNIVAC 1100/81 computer at DMAHTC. The data base software requires about 13,000 words of memory and uses the UNIVAC routines NTRAN and SORTSDF. Most runs are submitted in the batch processing mode.

The "MASTER FILE" uses 56 word, binary records, each with the same format. Thirty-one words are used in each record for storing the satellite and conventional survey information. The remaining space is reserved for adding new data elements. Coding and packing techniques of some information were used to minimize storage. A listing of the stored data elements is shown in Table 2. To provide direct access to the records stored in the "MASTER FILE", a table of contents file is maintained, giving the station number and its record location.

System programs were written to allow both the novice, who seldom uses the system, and the computer programmer, with technical skills to adapt the system to changing requirements, to effectively use the data base handling system. A schematic diagram showing the flow of this data handling system is shown in Figure 3.

Most users of the data base select only a portion of the "MASTER FILE" for use or display. The routine SORTFOR was written for this purpose. SORTFOR can search the "MASTER FILE" for all stations which meet certain input criteria, th sort these stations by a variety of sort keys. Retrieved data can be put on a temporary file for further processing or be displayed in several formats. The modular nature of the DGPP system allows easy addition of new formats.

The testing and sorting options are:

TEST OPTIONS

21 Located on certain continents.
22 Located within certain countries.
23 Station numbers within certain ranges.
24 Located within certain latitude belts.
25 Located within certain longitude belts.
26 Have certain AVAILABILITY CODES.
27 Have local control on certain datums.
28 Observed during certain time spans.

SORT OPTIONS

01 Sort by continent (or ocean) name.
02 Sort by country (or state) name.
03 Sort by station number.
04 Sort by latitude.
05 Sort by longitude.
06 Sort by station name.

The system gives the user a great deal of preprogrammed options for retrieving and sorting data from the data base. If an individual option is still not available, the system is simple enough for a FORTRAN programmer to write a retrieval routine to suit their particular needs.

Once the "MASTER FILE" data have been selected and sorted to the user's desires, system utility programs are available to output the data in a number of useful formats.

AVAILFOR:	Availability listing of satellite records data.
DUMPFOR:	The original 80-column four card dumps.
NWLWGSFOR:	Most used dump of basic information.
DATUM:	Derive datum transformation parameters.
STATIONFOR:	Data base updates using 80-column STATION CARD.
CHECKLISTFOR:	Data base updates using 80-column CHECKLIST CARD.
GEODETICFOR:	Data base updates using 80-column GEODETIC CARD.
ALTERMSL:	Data base updates using 80-column MSL CARD.
DELETE:	Delete records in the data base.

As indicated before, many system subroutines have been written to allow the do-it-yourselfer to use the data base. Even so, the SORTFOR routine is usually first used to select and sort the desired data. System subroutines make it possible for even inexperienced programmers to handle the information within the data base without ever really seeing the actual file format. The system's useful subroutines are:

AVTEST:	Testing AVAILABILITY Codes.
CHCARD:	Produce a CHECKLIST CARD image.
CONCAT:	Manipulate field data characters.
CONTCD:	Encoding and decoding continent names.
ELLIPS:	Retrieving ellipsoid parameters.
ELONG:	Converting west longitudes into east longitudes.
GDCARD:	Producing a GEODETIC CARD image.
LATCNV:	Encoding and decoding latitudes and longitudes.
MSCARD:	Producing an MSL CARD image.
PEEK:	Testing the table of contents file.
STCARD:	Producing a SATELLITE CARD image.
WGS72:	Satellite-derived coordinates in WGS72.

5. USER ACCEPTANCE OF THE SYSTEM

The real test of a Data Base Management System (DBMS) is how well it supports the work flow and how well the user accepts the system. Does one feel a great sense of job accomplishment at the end of the day, or frustrated because of system failures.

Since the users were very actively involved in the new system design, it is understandable that user acceptance is quite good. Also, since the original 80-column cards were retained as a means to up-date the data base, there was little

change to the basic operation and few errors have occurred. The "four-card" images can also be generated from the data base at any time. Existing programs could thus be executed without modifications (all of the existing programs have since been rewritten to take advantage of the features in the new DBMS).

Although the data base system consists of packed binary files to save space, users never need to know the details of how the data are formatted. To the users the storage medium is "format free". The DGPP data base system normally operates in a "read-only" mode in which the user only extracts information from the data base files. Updates to the data base files can only be performed by the data base administrator who has the keys to open and update the files and the responsibility for the file's integrity. Routine archiving is automatically accomplished by the UNIVAC SECURE Processor. Users have had little trouble with the system operation for both routine requests for data and new ever changing requirements on the system.

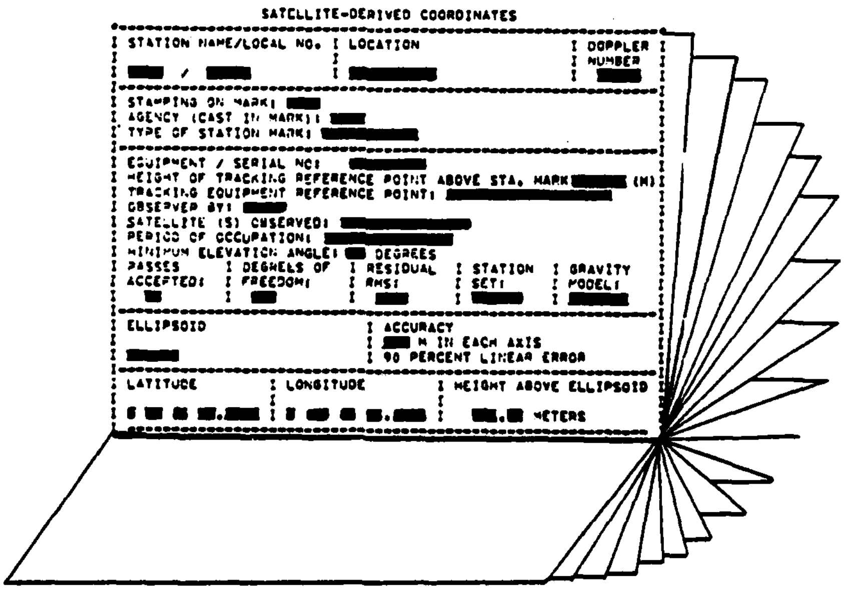
6. FUTURE PROBLEMS AND POSSIBLE SOLUTIONS

The relative ease with which Doppler Geodetic Point Positioning (DGPP) can be accomplished today has led to a rapid increase in the accumulation of data. The data base system has been able to accept this increase in data; however, with an anticipated large increase in satellite-derived coordinates in the future, running times will most likely be unacceptably excessive, and the operational efficiency should be improved.

The operation mode at DMA is also being shifted from batch towards a real-time and graphic display environment. The DGPP data base language is not well suited to real-time applications, and waiting time at a CRT is not acceptable.

In order to accommodate DoD requirements for geodetic information, the Geodetic Information System (GIS) has been established at DMAHTC. This system will not only contain the satellite-derived information but also will contain virtually all DMA geodetic data holdings. Not all data will be automated; some information is easily retrievable by manual or semi-automatic means, while other data may rarely be requested and be costly to compile. Determining which kind of information is to be stored in the GIS data base will probably be more demanding than how the data can be structured and stored in the management system.

This new GIS data base is currently in the design stage. Plans are again to make the system user-oriented. Updates to the system will not require a knowledge of a computer language. For instance, to update a satellite record, one could control a roll-index-file placed on the CRT screen. The speed which the card file is rotated could be controlled by terminal keys or "joystick". Updates would then be made by movement of the "pointer" to the desired data element and the entry or correction made.



The data base would then be automatically updated. Computer generated DGPP summary cards might appear as shown in Figure 4.

7. CONCLUSIONS

DMA carries out a continuing effort to collect and provide satellite-derived positions and terrestrial survey data to DoD and cooperating agencies. These geodetic data are furnished only to authorized recipients. Restrictions imposed on the distribution of data by the host country or by other sources are carefully honored.

The DGPP Data Base System described in this paper for handling geodetic data derived from satellite observations has served well. However, the size of the existing files are so small that almost any system would have served equally well. We have gained valuable experience through the implementation of this relatively simple data storage and retrieval system. The maintained integrity of the data base files and user acceptance has been rewarding.

Looking to the future, with larger and larger amounts of data, we will have to be more demanding on our data base system design and pay careful attention to standardization of information to be included in the DoD Geodetic Information System.

REFERENCES

PEROUTKA, M.R. (1979): A User's Guide to the Satellite Records Desk Master File.

DMA TM T-3-52320: Satellite Records Manual, Doppler Geodetic Point Positioning, Defense Mapping Agency, Washington, D.C. 20315, November 1976.

DMA TM T-2-52220: Field Operations Manual, Doppler Geodetic Point Positioning, Defense Mapping Agency, Washington, D.C. 20315, April 1975.

- Unique station number.
- Continent code.
- Country name.
- Station name.
- Country code.
- Equipment serial number.
- Datum of satellite-derived coordinates.
- Height of electrical center of antenna.
- Latitude, satellite-derived.
- Longitude, satellite-derived.
- Ellipsoid height satellite-derived.
- Dates of observation.
- Availability codes to other station records.
- Ellipsoid code, local coordinate.
- Adjustment date, local coordinate.
- Latitude, local coordinate.
- Longitude, local coordinate.
- Name of agency which performed local survey.
- Location of local survey records.
- Elevation (MSL).
- Geoid height (primary local system).
- Ellipsoid code, alternate system.
- Datum of local coordinate.
- Source of geoid height, primary system.
- Datum of alternate local coordinate.
- Source of alternate geoid height.
- Latitude, alternate local system.
- Longitude, alternate local system.
- Geoid height, alternate local system.
- Location of local survey records.
- Short arc indicator.

Table 2. LIST OF DATA ELEMENTS CONTAINED IN THE DGPP FILES.

SUMMARY OF SATELLITE-OBSERVED STATION

STATION NAME/LOCAL NUMBER 1	LOCATION 2	DOPPLER NO. 3
STAMPING ON MARK 4		
AGENCY (CAST IN MARK) 5	TYPE OF STATION MARK 6	

DOPPLER OBSERVATIONS

EQUIPMENT/SERIAL NO. 7	HEIGHT OF TRACKING EQUIPMENT REFERENCE POINT ABOVE STATION MARK: 8	TRACKING EQUIPMENT REFERENCE POINT 9
OBSERVED BY (AGENCY) 10	SATELLITE(S) OBSERVED 11	PERIOD OF OCCUPATION 12

SATELLITE-DERIVED COORDINATES

PASSES ACCEPTED 13	DEGREES OF FREEDOM: 14	RESIDUAL RMS 15	STATION SET 16	GRAVITY MODEL 17	ELLIPSOID 18	MINIMUM ELEV. ANGLE: 19

(Satellite-derived coordinates referred to station mark)

φ 20	λ 21	h 22	ACCURACY 23
X 24	Y 25	Z 26	

(Satellite-derived coordinates of station mark transformed to local datum)

φ 27	λ 28	h 29	DATUM 36
X 30	Y 31	Z 32	ELLIPSOID 37
ΔX 33	ΔY 34	ΔZ 35	DATE OF TRANSFORMATION 38

GROUND SURVEY COORDINATES OF STATION MARK

φ 39	λ 40	DATUM (HORIZONTAL) 41	ELLIPSOID 42
DATE OF ADJUSTMENT 43 / ORDER 44	SURVEY BY (AGENCY) 45	DATE	LOCATION OF SURVEY DATA 46
ELEVATION (H) 47	DATUM (VERTICAL) 48	GEOID HEIGHT (N) 49	ELLIPSOID HEIGHT (h) 50
ORDER (ELEV.) 51	ESTABLISHED BY (AGENCY) 52 DATE	SOURCE OF (N) 53	

CONNECTION TO LOCAL CONTROL

FROM	TO	(54) AZ FROM NORTH	DISTANCE
	55		

REMARKS

OTHER RELATED DATA FOR THIS STATION

DATA	AVAIL.	LOCATION/REMARKS
STATION OCCUPATION REPORT		
GEODETIC INFORMATION REPORT		
STATION DESCRIPTION		
SURVEY DIAGRAM	56	
STATION SITE SKETCH		
PHOTOIDENTIFICATION		
ASTRONOMIC COORDINATES		
STATION PHOTOS		

PREPARED BY/DATE 57	CHECKED BY/DATE	REVISED BY/DATE 58	CHECKED BY/DATE

DMA FORM 8290-1-R
SEP 78

Figure 1. SUMMARY OF SATELLITE-OBSERVED STATION CARD (SUMMARY CARD).

DATA AVAILABLE AT SATELLITE RECORDS DESK
SURVEYS WITH PORTABLE DOPPLER TRACKING EQUIPTMENT

STATION NUMBER	LAT.	LONG.	LOCATION	CONTINENT OR OCEAN	COUNTRY OR STATE	DATA AVAILABLE (OICDKEPLTSAH)*
10062	N 40 56	W 111 58	FARMINGTON	NORTH AMERICA	US-UTAH	O CDKEPL S H
51055	N 38 45	W 112 38	FILLMORE	NORTH AMERICA	US-UTAH	C L S H
36031	N 38 59	W 110 7	GREEN RIVER	NORTH AMERICA	US-UTAH	O CD EPL S H
52056	N 40 39	W 111 58	KEARNS	NORTH AMERICA	US-UTAH	C L S H
10061	N 38 29	W 109 44	MOAB	NORTH AMERICA	US-UTAH	O CDKEPL S H
31232	N 40 44	W 113 41	WENDOVER	NORTH AMERICA	US-UTAH	O CD E L S
51020	N 44 54	W 73 17	ALBURG	NORTH AMERICA	US-VERMONT	C L S H
30046	N 38 50	W 77 10	ANNANDALE	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30045	N 38 49	W 77 13	ANNANDALE	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30048	N 38 53	W 77 7	ARLINGTON	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30047	N 38 54	W 77 10	ARLINGTON	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
51107	N 37 56	W 75 27	CHINCOTEAGUE	NORTH AMERICA	US-VIRGINIA	C L S H
51003	N 38 12	W 77 22	CORBIN	NORTH AMERICA	US-VIRGINIA	C L S H
31000	N 38 23	W 77 3	DAHLGREN	NORTH AMERICA	US-VIRGINIA	O C E S
30267	N 36 41	W 77 28	EMPORIA	NORTH AMERICA	US-VIRGINIA	O CD E TS
30042	N 38 53	W 77 22	FAIRFAX	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30043	N 38 51	W 77 19	FAIRFAX	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30044	N 38 47	W 77 26	FAIRFAX	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
51011	N 37 19	W 78 26	FARMVILLE	NORTH AMERICA	US-VIRGINIA	O C L S H
30264	N 38 16	W 78 53	GROTTOES	NORTH AMERICA	US-VIRGINIA	O CD E TS
30072	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	O CD E L S H
30039	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30073	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	O CD E L S H
30079	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	O CD E L S H
30071	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	O CD E L S H
30684	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30690	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	C L S H
30682	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	O CD E L S H
30691	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	C L S H
31385	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	C L S H
31383	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	C L S H
31384	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	C L S H
31388	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	C L S H
31386	N 39 0	W 77 19	HERNDON	NORTH AMERICA	US-VIRGINIA	C L S H
30069	N 38 56	W 77 19	KENT	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30041	N 39 2	W 77 32	LOUDOUN	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
36040	N 38 55	W 77 40	MANASSAS	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
30049	N 38 57	W 77 13	MCLEAN	NORTH AMERICA	US-VIRGINIA	O CDKE L S H
80044	N 38 57	W 77 22	POWELL ECC 1977	NORTH AMERICA	US-VIRGINIA	C L S H
30068	N 39 2	W 77 18	SOUTHDOWN	NORTH AMERICA	US-VIRGINIA	O CDKE L S H

*SEE THE FOREWORD OF THIS LISTING FOR EXPLANATION OF CODE.

Figure 2. SAMPLE PAGE OF DMAHTC LIST OF HOLDINGS OF SURVEYS MADE WITH PORTABLE DOPPLER TRACKING EQUIPMENT.

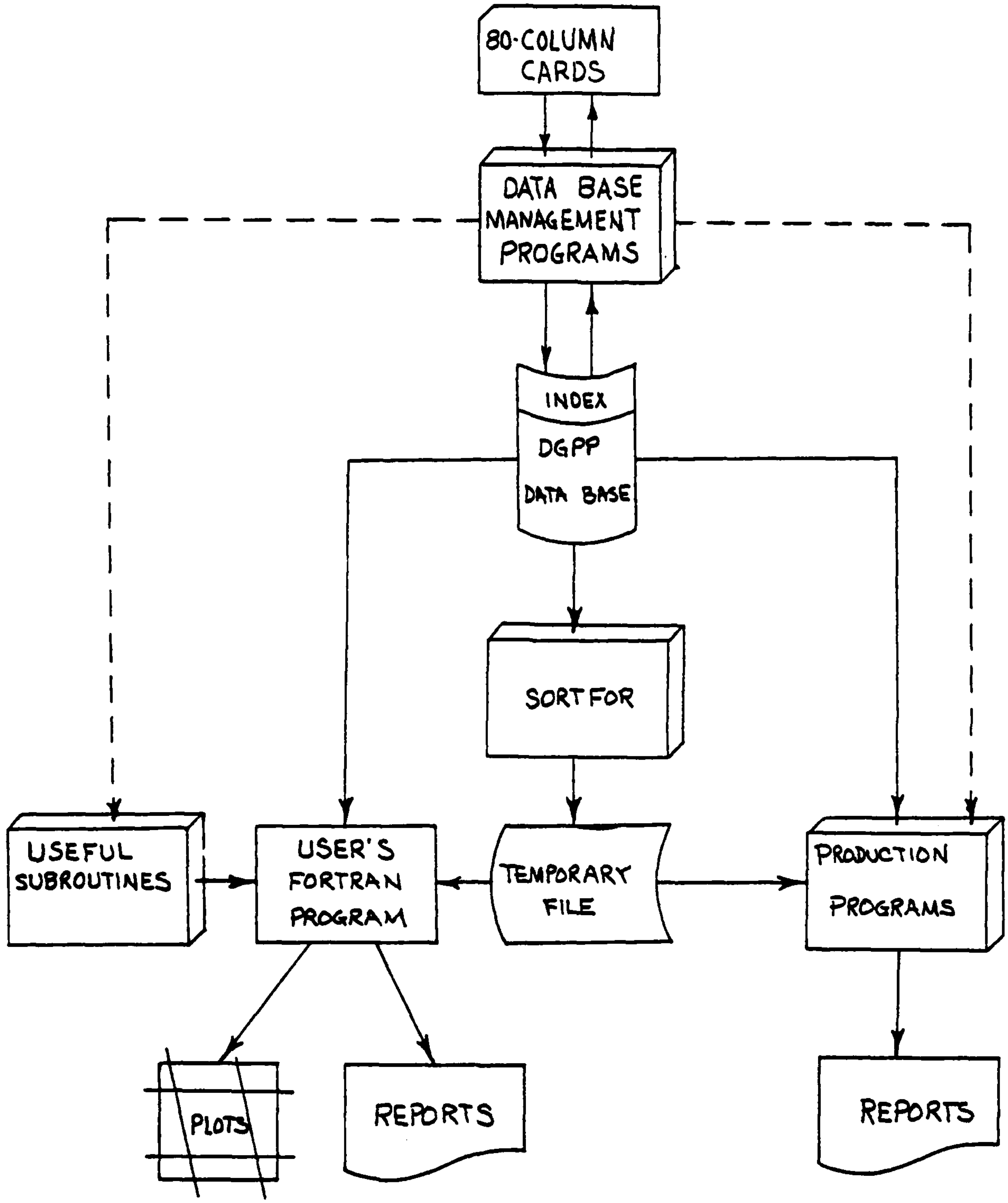


Figure 3. FLOW CHART OF THE DOPPLER GEODETIC POINT POSITIONING DATA BASE HANDLING SYSTEM.

```
                 SATELLITE-DERIVED COORDINATES
I STATION NAME/LOCAL NO. I LOCATION                I DOPPLER I
I                        I                         I NUMBER  I
I W 83 ECCENTRIC         I HERNDON, VA             I  30039  I
I---------------------------------------------------------------I
I STAMPING ON MARK: W 83 ECC 30039                              I
I AGENCY (CAST IN MARK): DEFENSE MAPPING AGENCY                 I
I TYPE OF STATION MARK: BRONZE DISK                             I
I---------------------------------------------------------------I
I EQUIPMENT / SERIAL NO:    GEOCEIVER DHD-044                   I
I HEIGHT OF TRACKING REFERENCE POINT ABOVE STA. MARK:0.993 (M)   I
I TRACKING EQUIPMENT REFERENCE POINT: RED BAND ON ANTENNA        I
I OBSERVER BY: DMAHTC                                           I
I SATELLITE (S) OBSERVED: 30130 AND 30190                       I
I PERIOD OF OCCUPATION: 16-22 JULY 1974                         I
I MINIMUM ELEVATION ANGLE: 10 DEGREES                           I
I PASSES     I DEGREES OF  I RESIDUAL  I STATION  I GRAVITY      I
I ACCEPTED:  I FREEDOM:    I RMS:      I SET:     I MODEL:       I
I   36       I  698        I  0.24     I NWL 9D   I NWL 10E      I
I---------------------------------------------------------------I
I ELLIPSOID                      I ACCURACY                     I
I                                I 1.5 M IN EACH AXIS           I
I NWL 8E                         I 90 PERCENT LINEAR ERROR      I
I---------------------------------------------------------------I
I LATITUDE          I LONGITUDE          I HEIGHT ABOVE ELLIPSOID I
I                   I                    I                       I
I N 38 59 44.426    I W  77 18 44.219    I   70.77 METERS        I
I ------------------------------------------------------------  I
I X-COORDINATE      I Y-COORDINATE       I Z-COORDINATE          I
I                   I                    I                       I
I  1090210.51 M     I  -4842485.84 M     I 3991992.77 M          I
I---------------------------------------------------------------I
I      SATELLITE-DERIVED COORDINATES OF STATION MARK            I
I                TRANSFORMED TO LOCAL DATUM                     I
I                                                               I
I LATITUDE          I LONGITUDE          I HEIGHT ABOVE ELLIPSOID I
I                   I                    I                       I
I                   I                    I                       I
I ------------------------------------------------------------  I
I X-COORDINATE      I Y-COORDINATE       I Z-COORDINATE          I
I                   I                    I                       I
I                   I                    I                       I
I---------------------------------------------------------------I
I DX=               I DY=                I DZ=                   I
I DATUM:                                                        I
I ELLIPSOID:                                                    I
I DATE OF TRANSFORMATION:                                       I
I---------------------------------------------------------------I
I REMARKS                               I OTHER RELATED DATA    I
I                                       I AVAILABILITY:         I
I                                       I OICDKEPLTSAH          I
I                                       I XX XXXXX X X          I
I                                       I                       I
I                                       I                       I
```

```
          GROUND SURVEY COORDINATES OF STATION MARK
I PROJECT                               I STATION                I
I                                       I                        I
I                                       I W 83 ECCENTRIC         I
I----------------------------------------------------------------I
I ELLIPSOID                             I GEOID HT. I ELEV. (M)  I
I                                       I           I            I
I CLARKE 1866                           I  -2.   M  I   111.71   I
I----------------------------------------------------------------I
I LATITUDE         I                    I DATUM     I DATUM      I
I                  I                    I           I            I
I N 38 59 44.120   I W  77 18 44.483    I NAD 1927  I MSL        I
I----------------------------------------------------------------I
I SURVEYED BY      IDATE OF ADJUSTMENTI ORDER      I ORDER      I
I                  I                    I           I            I
I  DMAHTC          I 1972               I 3RD       I 3RD        I
I----------------------------------------------------------------I
I ESTABLISHED BY   I DATE               I LOCATION OF SURVEY DATAI
I                  I                    I                        I
I  DMAHTC          I MAR 72             I DMAHTC                 I
I----------------------------------------------------------------I
I  CONNECTION TO LOCAL CONTROL I GEODETIC AZ. I   DISTANCE       I
I                              I (FROM NORTH) I   (METERS)       I
I----------------------------------------------------------------I
I 30070                        I   2 41 17.   I     12.748       I
I 30071                        I  92 28 20.   I     15.034       I
I 30072                        I 182 37 41.   I     11.875       I
I 30073                        I 272 18 57.   I     13.271       I
I HERNDON OPTRACK              I 289 25 05.7  I     61.949       I
I----------------------------------------------------------------I
I REMARKS                                                        I
I                                                                I
I   SOURCE OF GEOID HEIGHT: AMS GEOID CHART 1967                 I
```

Figure 4. POSSIBLE AUTOMATION EXAMPLE OF THE SUMMARY OF SATELLITE-OBSERVED STATION CARD.